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(54) CLEAN AIR ZONE

(71) We, HOWORTH AIR ENGINEERING LIMITED, a British Company, of Victoria Works, Farnworth, Bolton, BL4 7LZ, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an apparatus for generating a clean air zone beneath the apparatus, for example in an operating theatre, in a pharmaceutical "clean room" where drugs or chemicals are being prepared or processed, or in an electronics "clean room" wherein electronic components are assembled. Attention is drawn to our co-pending application No. 45468/78, (Serial No. 1555564) which is divided herefrom. Attention is also drawn under Section 9 of the Patents Act 1949 to our Patents Nos. 1488513 and 1488514.

Many installations for this purpose are known which rely on a downwardly flowing stream of clean air to sweep a desired clean area and discourage or prevent contamination approaching the working area. One known installation provides for a whole room to have air supplied through its ceiling and withdrawn at the base of the room. However this needs to be incorporated at the design stage of the building, and is very expensive. Other known installations have ceiling level air supply apparatus generating downward clean air flows enclosed by solid walls or walls of high speed air, (a so-called "air-curtain"), i.e. air moving substantially faster than the air supplied to the clean area inside the "curtain". Unfortunately the solid walls heavily restrict access to the working area and the approach of workers via double doors enables contamination to enter.

The "air-curtain" has the disadvantage that when broken it actively encourages the entrainment of contamination into the slower-moving air inside it, and can also "stir-up" contamination from the floor. Both these latter installations also have the disadvantage that the clean area generated is only of the same or smaller area than the air supply apparatus, and thus if a large clean area is needed a correspondingly larger, and thus more expensive apparatus is required. Many known installations are also not re-circulatory, which, although it does not impair the efficiency of the apparatus, means that the input to the supply apparatus is substantially of ambient "dirty" air. This has the effect that the usual filters in the air supply apparatus have to cope with a constant flow of "dirty" air and must be cleaned at relatively frequent intervals.

An object of the present invention is to provide an improved apparatus for generating a clean air zone beneath the apparatus, wherein some or all of the above disadvantages are obviated or minimised.

The present invention provides apparatus for generating a clean air zone beneath the apparatus, comprising a housing enclosing a fan and a filter, and having a lower one face and perimetral lateral side walling including a plurality of side faces, there being provided an air outlet in the one face for supplying air to the space beneath the lower one face, and an air inlet being provided in each of said side faces so as to be distributed about the perimetral lateral side walling so that, in operation, air from the outlet passes firstly downwardly into the space directly below the lower one face, secondly laterally outwardly of said space, and thirdly upwardly to the inlets so as to sweep a volume greater than the volume of the space directly beneath the one face to generate a clean air zone whose perimeter lies outside the perimeter of the lower one face of the housing.

A plurality of fans can be provided in the housing, each arranged to draw air from one of said inlets and direct it towards the centre of the housing.

Each fan can conveniently be arranged adjacent the junction of two of said side faces.

The apparatus is conveniently in the form of a canopy having a plenum chamber or a plurality of plenum chambers supplying

delivery means of different permeabilities to provide different air speeds.

Distribution of the inlets about the periphery of the apparatus has the effect of creating a clean zone which extends a considerable distance outside the area directly beneath the apparatus itself. This is in contradistinction to known apparatus, wherein inlets have been provided at floor level or at one side only.

The invention will be described further, by way of example, with reference to the accompanying drawings, wherein:

Fig. 1 is a transverse cross-sectional schematic view of a preferred apparatus of the invention, the cross-section taken on the line I—I of Fig. 2.

Fig. 2 is an inverted plan view of the apparatus of the invention.

Fig. 3 is a fragmentary perspective cutaway view of one module forming part of the apparatus of the invention, parts having been omitted for clarity.

Fig. 4 is an enlarged fragmentary cross-section on the line IV—IV of Fig. 2, showing details of a fan.

A preferred embodiment of apparatus 10 conforming to the invention is suitable for attachment to the ceiling of an operating theatre to provide a clean air zone around a patient undergoing surgery, or to the ceiling of a pharmaceutical or electronics clean room to provide a clean air zone around a machine or a manufacturing process. Instead of being ceiling mounted, the apparatus could be mounted on a wheeled frame to render it mobile and to enable it to be moved from, say, one machine to another.

The apparatus 10 is in the form of a unit constructed from four modules 11, one of which is shown in detail in Fig. 3. Each unit thus has four air supply means constituted by fans 12, and an outlet including three air delivery means (Fig. 2) constituted by areas of diffuser plates 13 of the modules 11.

A central one of the air delivery means is in the form of a square panel 14 of relatively high permeability (i.e. it has more and/or larger apertures than the other air delivery means) and in use delivers air at a linear velocity from 90—130 f.p.m. (preferably 110 f.p.m.). A second of the air delivery means is in the form of a panel 15 surrounding panel 14 and so perforated as to deliver air at a linear velocity of 60—90 f.p.m. (preferably 75 f.p.m.). A third of the air delivery means in the form of a panel 16 surrounding panel 15 and so perforated as to deliver air at a linear velocity of 20—60 f.p.m. (preferably 40 f.p.m.). It must be noted, however, that whilst the velocities of the flows from the delivery means can vary, there should always exist a differential between adjacent flows of at least 5 f.p.m. and preferably over 20 f.p.m.

As has been previously mentioned, the apparatus 10 is in the form of a unit constructed from four modules 11. Referring now to Fig. 3, each module 11 is made of sheet metal and has a generally square top plate 17, an L-shaped base plate 18 and a rectangular perforated diffuser plate 13. Plate 13 has three distinct areas of different permeability (indicated by the variable cross-hatching at 19, 20, 21 in Fig. 2) to achieve the aforesaid different flow velocities. Each plate 13 is hinged at 22 (Fig. 1) to facilitate servicing and cleaning.

The module 11 has closed inner adjacent side walls 23, 24 and side walls 25, 26 constituting part of lateral side walling of the apparatus, each having an elongate inlet window 27. Parallel to these latter walls and along the inner edges of the L-shaped base plate extend internal walls 28 and 29 which help to define an inner compartment of the module and fan inlet chambers 30 and 31. Each inlet window is closed by a hinged panel 32 (Figs. 1 and 2) carrying a pre-filter pad 33 for removing coarse contaminants from incoming air.

The inner compartment of module 11 has a shallow sheet metal tray 34 therein which has apertures 35 and which supports filter pads 36. Below the tray 34 and above the plate 13 is a plenum chamber 37 and above the pads 36 and below top plate 17 is an intake or plenum chamber 38 to which air is supplied by a fan 12 (Fig. 4). The fan 12 has been omitted from Fig. 3 for clarity.

Turning now to Fig. 4, it will be seen that each fan 12 is a conventional radial flow fan having two axial inlets 39 and 40 and a tangential outlet 41 which discharges into intake chamber 38. The inlets 39 and 40 face and take air from fan inlet chambers 30 and 31. A rotor and an electric motor of the fan have not been illustrated.

From the arrows in Figs. 1 and 2 it will be appreciated that a basically re-circulating air system is employed, thus generating a clean air zone beneath the air delivery means and a swept air zone surrounding the delivery means. This results in a clean air zone of effectively larger area than the area directly beneath the apparatus 10. The re-circulating feature also means that the filters have to be replaced at less frequent tervals as they are not continuously filtering dirty ambient air as they would be in a non-circulatory system.

A short wall 42 (Fig. 1) can be provided to give some guidance to the downwardly flowing air. The apparatus can be mounted on a trolley to enable it to be moved to be positioned above a particular area or machine.

It will be appreciated that the present invention is equally applicable to apparatus wherein only a single velocity stream of air

is provided, the distributed inlets still providing the increased area feature and encouraging a downwardly, outwardly and then upwardly flowing air stream. There is always a flow of air away from the centre of the zone which inhibits the ingress of contamination, even from objects and persons entering the outer areas of the zone.

WHAT WE CLAIM IS:—

1. Apparatus for generating a clean air zone beneath the apparatus, comprising a housing enclosing a fan and a filter, and having a lower one face and perimetral lateral side walls including a plurality of side faces, there being provided an air outlet in the one face for supplying air to the space beneath the lower one face, and an air inlet being provided in each of said side faces so as to be distributed about the perimetral lateral side walling so that in operation, air from the outlet passes firstly downwardly into the space directly below the lower one face, secondly laterally outwardly of said space, and thirdly upwardly to the inlets so as to sweep a volume greater than the volume of the space directly beneath the one face to generate a clean air zone whose perimeter lies outside the perimeter of the lower one face of the housing.

2. Apparatus as claimed in Claim 1 wherein a plurality of fans are provided in the housing, each being arranged to draw air from one of said inlets and direct it towards the centre of the housing.

3. Apparatus as claimed in Claim 2 wherein each fan is arranged adjacent a junction of two of said side faces.

4. Apparatus as claimed in Claim 1, wherein the inlets are regularly distributed.

5. Apparatus as claimed in any preceding Claim, wherein each inlet incorporates a pre-filter.

6. Apparatus as claimed in any preceding Claim, and including a plurality of fans.

7. Apparatus as claimed in Claim 6, wherein the housing is rectangular, so that there are four said side faces, and a fan is provided at each corner thereof, each fan being associated with an elongate inlet in the adjacent side wall of the housing on either side thereof.

8. Apparatus as claimed in Claim 5 or 6, wherein each fan discharges into an individual plenum chamber.

9. Apparatus as claimed in any preceding claim, wherein the air outlet includes delivery means adapted to supply a first central air stream at a first velocity and a second outer surrounding airstream at a second lower velocity.

10. Apparatus as claimed in Claim 9, wherein the delivery means is adapted to supply a further air stream, around the second air stream, at a third, still lower, velocity.

11. Apparatus as claimed in Claim 9 or 10, wherein the delivery means is in the form of diffuser plates having areas of different permeabilities.

12. Apparatus as claimed in Claim 11, wherein the diffuser plates have different permeabilities by being provided with areas having different numbers of apertures and/or different sizes of apertures.

13. Apparatus as claimed in any preceding claim and being ceiling mounted.

14. Apparatus as claimed in any of Claims 1 to 12 and being mounted on a trolley so as to be capable of being positioned above a particular area or machine.

15. Apparatus for generating a clean air zone beneath the apparatus, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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Sheet 1

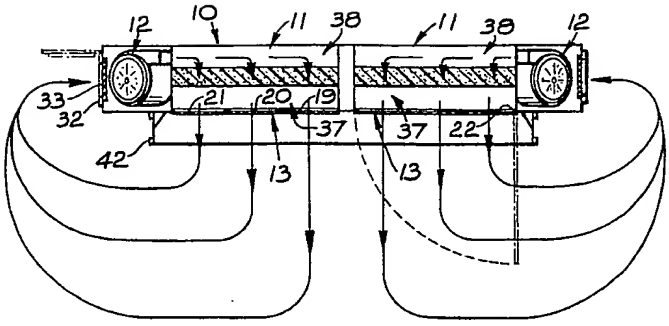

Fig. 1.

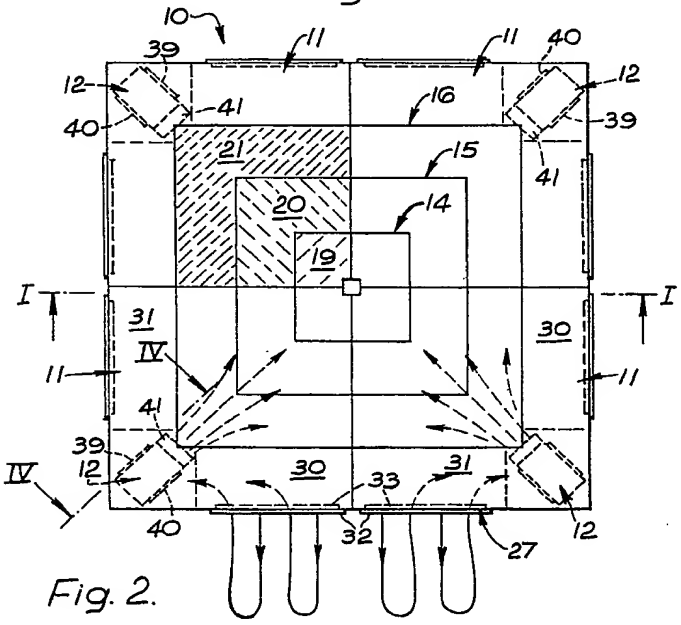

Fig. 2.

1555563 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

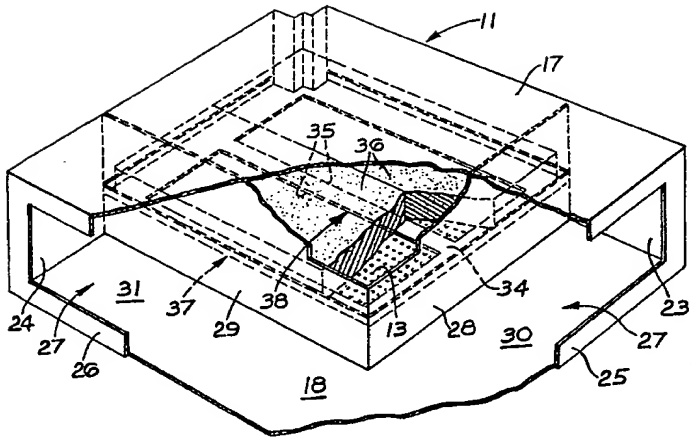

Fig. 3.

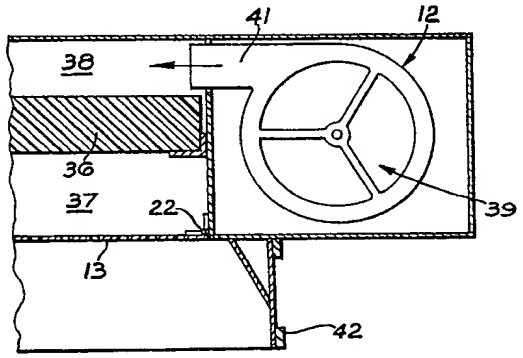

Fig. 4.